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ECONOMIC ANALYSIS OF ALTERNATE ROUTINGS OF LIVINGSTON-GARDINER HIGHWAY (FEDERAL AID ROUTE 11)-BETWEEN CARTER BRIDGE AND DAILEY VICINITY

April 19, 1956

FOREWORD

The purpose of this analysis is to appraise the relative merit of two proposed routings of Federal Aid Route 11 between a point near the Carter Bridge southwesterly to another point north of Carbella and near Dailey Lake.

One alternate involves the reconstruction of the present route on the east side of the Yellowstone River between these two points. Practically all of this roadway is about 25 years old and is obsolete with respect to present standards for serving primary system traffic.

The other alternate provides for the relocation of the entire section of highway on the west side of the river. A preliminary survey discloses that this routing could be located between the river and the branch line of the Northern Pacific Railway operating between Livingston and Gardiner.

In order to compare the relative merit of the two routes, it is necessary to determine the relationship between the annual costs and the respective annual benefits for each route. The route having the highest ratio of benefits to costs should be considered the most favorable routing.

GENERAL DESCRIPTION OF AREA

The area embraced by this analysis includes a well developed portion of the Yellowstone River valley south of Livingston. It comprises a large basin which is approximately bisected by the river. The greatest development is located on the east side of the river where the holdings are generally smaller. The ranches are mostly devoted to the raising of livestock and related activities. A large portion of the land is irrigated from the numerous streams descending from the nearby mountain range. The east side of the river also has greater commercial development, which is due mostly to the presence of the main highway on this side. Commercial areas include developments at Pine Creek, Chico and Montanopolis Hot Springs and at a point south of Pray. This side is the location of a high school bus route which begins at a point south of Pray and collects pupils en route to the high school at Livingston. There is also another minor elementary school bus route which carries the pupils from the Emigrant vicinity on the west side of the river to the school house which is located near Pray on the east side.

An RFD mail route extends from Livingston up the east side of the river to a point near Mill Creek, returns and crosses the river near Pine Creek, extends westward to the Hoffman vicinity and then returns to the Carter Bridge junction on the west side of the river.

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The area on the west side of the river is not as well developed as the east side. The ranches here are larger and are more sidely spaced. They also are predominantly livestock ranches. There is considerable irrigated land along the streams and the river bottom where the terrain is favorable for irrigation. The small community of Emigrant is located on this side of the river. A branch line of the Northern Pacific Railway is also located on this side of the river between Livingston and Gardiner. Passenger service has been discontinued on this line, and freight hauling is restricted to one round trip per week. Passengers and some freight between Livingston and Gardiner are carried on a combination bus operating on the east side of the river on the present highway.

A rural road inventory was made in Park County in 1951 which disclosed the following distribution of culture in the area between the Carter Bridge and the Dailey area:

Description	East Side	West Side
Farms	102	48
Active Schools	5	1
Non-Farm Dwellings	9	0
Seasonal Dwellings	9	3
Churches	2	1
Camp Grounds	5	1
Ranger Stations	3	1
Post Offices	1	1
Fish Hatchery	1	0
Mines	0	2
Sawmill	0	1
Businesses	4	2
TOTAL	141	61

There may be some change in this inventory since it was taken in 1951, but it is believed to be representative of the general development in the region.

Present bridges over the river include the Carter Bridge, a county bridge between Brisbin and Pine Creek, FAS bridge near Emigrant and the Carbella county bridge south of the proposed new bridge near Dailey Lake.

TRAFFIC

The present primary highway on the east side of the river carries a substantial volume of traffic.Counts show 1,000 vehicles per day near the Carter Bridge. About 600 per day near Emigrant Junction, and about 500 per day near Carbella. The average for the section of highway under consideration amounts to 664 vehicles per day. Out-of-state tourist traffic amounts to 63% of the total; other passenger cars represent 28% of the traffic; and trucks account for 9% of the traffic. Most of this truck traffic consists of light farm trucks of local origin.

Traffic on the present county road on the west side of the river amounts to 135 vehicles per day near the Carter Bridge, another concentration of 117 vehicles per day near Emigrant, and about 30 vehicles per day near Dailey. The average for the entire road is about 60 vehicles per day. This traffic is predominantly of local origin, but there is a small amount of recreational traffic. The recreational traffic would undoubtedly be greater if ready access to the river were obtainable on the west side.

Estimated distribution of traffic is shown in the following table:

	EAST SIDE		WEST SIDE	
TYPE OF TRAFFIC	Present	Future	Present	Future
Local:				
Passenger	136	170	40	50
Truck	50	63	10	15
	186	233	50	65
Induced Local:				
Passenger			20*	25*
Truck			5*	6*
			25*	31*
TOTAL LOCAL	186	233	75	96
Recreational:				
Present	50	100	10	20
Induced			30*	60*
TOTAL RECREATIONAL	50	100	40	80
COMMERCIAL TRUCK	10	20	10*	20*
TOURIST	418	836	418*	836*
GRAND TOTAL	664	1189	543*	1032*
TRUE PRESENT			60	

* - This traffic represents the potential traffic which could be expected to use the west side road if it were constructed to the proper primary standard.

The present traffic on the west side amounts to 60 vehicles per day, but in order to make an equitable comparison in an analysis of this type, it is necessary to base the calculations on the potential traffic for both routes. For this reason, the present traffic on the west side has been expanded to the estimated potential.

The future traffic shown in this table represents the average daily traffic which could be expected to use the route during the next thirty years. This thirty year period represents the estimated life of the new construction on either side of the river.

It is believed that this general region has reached approximate maturity insofar as local development and local traffic are concerned. On this assumption, it is estimated that the local traffic will increase about 25% as the average for the next 30 years. Tourist traffic, on the other hand, has increased at a rapid rate since the war. From 1947 to 1954, the tourist traffic between Gardiner and Emigrant Junction has increased 42%; between Emigrant Junction and Livingston, it has increased 139%.

On the basis of this expansion, it is estimated that the average increase in tourist traffic during the next 30 years will equal 100%. It is estimated that there will be a corresponding increase in the recreational and other through traffic.

CONSTRUCTION COSTS

The age of the present highway on the east side of the river averages about 25 years. A portion of the highway was graded and graveled in 1926 and was surfaced in 1929. The remainder of the roadway was constructed and surfaced in 1929. The majority of the original surface is still in use, however, a part of it has been resurfaced since that date. The present Carter Bridge was built in 1921 and was widened as a temporary expedient in 1954.

In order to comply with present requirements for serving Primary System traffic, it is necessary that this section of road be rebuilt. It is estimated that about one-third of the present highway will have to be relocated in order to obtain the necessary alignment and to avoid slide conditions. The remaining two-thirds may be reconstructed on approximately the same location with the purchase of additional right-of-way. The relocated sections will bypass the two present principal commercial areas.

Because of the numerous irrigation facilities and streams on the east side, the cost of drainage features will exceed similar facilities on the west side. Another feature which will increase construction costs on the east side is the necessity of providing for the maintenance of traffic during the construction period.

The present highway on the east side is 32.3 miles long. Upon reconstruction, this length will be reduced to 32.0 miles.

The entire section of highway on the west side of the river will be built on location between the river and the railroad track. This will not present unusual difficulty except at the north end where the river crowds the track. High grading costs will be encountered at this point and at other points where there is a high water table.

Surface and base material is plentiful on both sides of the river, and the costs for these items will be about equal for either side.

If the highway is reconstructed on the east side of the river, it will be necessary to replace the present Carter Bridge. If the highway is located on the west side of the river, it will be necessary to build a new bridge over the river near Dailey. Both of these bridges will be of about the same length and will have equal construction costs.

The construction length of the highway on the west side of the river will be about 30.5 miles, or about 1.8 miles shorter than the present highway on the east side of the river.

The location on the west side of the river will provide better grade and alignment, although the difference would not be of sufficient extent to enter into the appraisal of benefits. The flow of traffic on the west side will also be better because of the absence of numerous intersecting roads as there are on the east side.

Estimated construction costs are compared in the following table:

ESTIMATED CONSTRUCTION COSTS

COST ITEM	ESTIMATED LIFE-YEARS	EAST SIDE COSTS TOTAL	EAST SIDE COSTS ANNUAL	WEST SIDE COSTS TOTAL	WEST SIDE COSTS ANNUAL
R/W & Utilities	40	$ 66,491	$ 1,662	$ 58,575	$ 1,464
Grading & Drainage	30	585,016	19,499	751,840	25,059
Base & Surface Later Resurfacing	30	1,198,493 240,000	47,945	962,085 228,750	39,690
Yellowstone Bridge	40	350,000	8,750	350,000	8,750
Other Bridges	30	135,000	4,500	90,000	3,000
Maintenance of Traffic	30	150,000	5,000	- -	- -
TOTAL CONSTRUCTION COST		$2,725,000	$87,356	$2,441,250	$77,963
ANNUAL MAINTENANCE AT $750 PER MILE			$24,000		$22,875
TOTAL ANNUAL COST			$111,356		$100,838
ANNUAL COST PER MILE			$ 3,480		$ 3,306

The annual cost and the annual cost per mile would both be lower on the west side location.

BENEFITS

For the purpose of computing benefits, the traffic may be divided into two major groups: local traffic and through traffic. Insofar as through traffic is concerned, it may be presumed that there would be no preference for either routing. This traffic has origins and destinations beyond the limits of the relocated highway, so there would be no advantage to either routing insofar as location is concerned. There would be greater benefits on the west side location, however, since this location would involve shorter travel distance of 1.5 miles for this type of traffic.

Local traffic would have a decided interest in the location of the routing. It is natural that the residents on the east side of the river would prefer to have the highway on that side. Likewise, the residents on the west side of the river would prefer to have a new highway on that side of the river in place of the present low standard road. There are also a few residents who would benefit from either location since they would be able to utilize one of the present bridges in crossing to either highway.

An unusual situation exists on the west side with respect to service to local traffic. Since the new highway would be located between the river and the railroad, the railroad would act as a barrier separating many of the local residents from the highway. On the south half of the route, the present county road crosses the railroad at several points, and this would provide access to the new highway. The residents in the northern half of the area, however, would have difficulty in crossing the railroad to get on the new highway. In most cases, it would be necessary for these residents to travel a greater distance than the present travelled way in order to reach a crossing. Despite this extra travel, most of these residents would benefit from the new highway since they would be able to travel at least a part of the distance on paved highway rather than the lower standard county road. It would also be possible that new crossings could be provided at strategic points to improve the access to the new highway.

Traffic on the east side of the river would not experience a significant amount of benefit per vehicle mile if the highway is reconstructed on that side of the river. These residents already have an oiled highway to serve the general area, and there would not be appreciable additional benefit through reconstruction of this highway. The alignment would be improved somewhat and there would be a minor shortening of travel distance for part of the residents. For other residents, the travel distance might be increased because of the fact that the highway would have to be relocated in some instances at a distance from the existing dwellings in order to obtain satisfactory alignment. There would not, however, be the substantial benefits in changing from a low standard road to an improved highway as would result from construction on the west side of the river.

The following table presents a comparison of benefits as computed for the two alternates:

BENEFITS TO EAST SIDE TRAFFIC

	Average Daily Traffic	Annual Traffic (x 365)	Roadway Length	Annual Vehicle Miles	Travel Cost Per VM	Total Travel Cost
Local Traffic:						
Present conditions	186	67,890	32.3	2,192,847	$.0948	$207,882
New conditions	186	67,890	32.0	2,172,480	.0921	200,085
ANNUAL SAVINGS			0.3	20,367		7,797
Through Traffic:						
Present conditions	478	174,470	32.3	5,635,381	.0763	429,980
New conditions	478	174,470	32.0	5,583,040	.0741	413,703
ANNUAL SAVINGS			0.3	52,341		16,277
TOTAL SAVINGS - EAST SIDE						$ 24,074
CONVERTED TO FUTURE ANNUAL AVERAGE FOR 30 YEAR PERIOD						$ 42,300

The travel costs per vehicle mile, as shown in the foregoing table, were derived from a publication of the American Association of State Highway Officials. These costs include such operating costs as fuel, oil, tires, maintenance, and repairs. An allowance is also made for the value of time savings and comfort and convenience. The amounts shown for local traffic are higher than those shown for through traffic because of the greater proportion of trucks in the local traffic category.

The total annual savings of $24,074 have been computed on the basis of present traffic. Since the costs for construction and maintenance have been computed for a future annual average during the estimated 30 year service life of the highway, it is also necessary to project the annual benefits for the same 30 year period. This has been accomplished by increasing the benefits to local traffic by 25% and by increasing the benefits to through traffic by 100%. These increases correspond to the estimated average expansion in traffic during this period.

Benefits to the west side traffic are shown in the following table:

BENEFITS TO WEST SIDE TRAFFIC

	Average Daily Traffic	Annual Traffic (x 365)	Roadway Length	Annual Vehicle Miles	Travel Cost Per VM	Total Travel Cost
Local Traffic:						
Present conditions	75	27,375	30.8	843,150	.1176	$99,154
New conditions	75	27,375	31.5	862,312	.0938	80,884
ANNUAL SAVINGS			(0.7)	(19,162)		$18,270
Through Traffic:						
Present conditions	478	174,470	32.3	5,635,381	.0763	429,980
New conditions	478	174,470	30.5	5,321,335	.0741	394,311
ANNUAL SAVINGS			1.8	314,046		$35,669
TOTAL SAVINGS - WEST SIDE						$53,939
CONVERTED TO FUTURE ANNUAL AVERAGE FOR 30 YEAR PERIOD						$94,176

The unit cost per vehicle mile of travel on the west side for the local traffic operating under present conditions, is higher than the corresponding figure for local traffic on the east side because of the fact that the west side traffic must travel over earth and gravel roads. The unit cost per vehicle mile for local traffic under the new conditions is also higher than the corresponding figure for the east side traffic for the reason that restricted access to the new highway will make it necessary for the local residents to continue to use the present low standard road for at least part of their travel.

The same traffic figures and unit benefit values are used for the through traffic on both sides of the river however, the total computed benefits will be greater for the traffic on the west side because of the extra distance savings realized on this routing.

It may be noted that these computations show that the local traffic on the west side of the river actually will have to travel an average of 0.7 miles farther under the new conditions than they do at the present time on the county roads. As explained before, this situation arises because of the fact that the new highway will be located on the opposite side of the railroad and at some distance from certain areas of development in this vicinity. This will involve additional travel in some instances for the residents to gain access to the new highway. This extra travel produces a negative benefit insofar as the number of vehicle miles are concerned, but this negative benefit will be more than offset by the value of other benefits resulting from the ability to travel a major part of the distance on a paved highway rather than on the lower standard county road.

For comparison purposes, the value of benefits on both sides of the river are shown below:

COMPARISON OF BENEFITS ON ALTERNATE ROUTINGS

	Local Traffic	Through Traffic	Total	Future
WEST SIDE HIGHWAY	$ 18,270	$ 35,669	$ 53,939	$ 94,176
EAST SIDE HIGHWAY	7,797	16,277	24,074	42,300
EXTRA BENEFITS ON WEST SIDE	$ 10,473	$ 19,392	$ 29,865	$ 51,876

COMPARISON OF COSTS TO BENEFITS

The foregoing material has reviewed the manner in which traffic, cost and benefit figures have been developed for each route. In order to compare the relative standing of each route it is necessary to determine the relationship between the costs for each route and the corresponding benefits which would accrue to the traffic on these routes. These relationships are shown below:

COMPARISON OF BENEFIT/COST RATIOS

	EAST SIDE HIGHWAY	WEST SIDE HIGHWAY
ANNUAL CONSTRUCTION AND MAINTENANCE COSTS	$ 111,356	$ 100,838
VALUE OF ANNUAL BENEFITS	$ 42,300	$ 94,176
BENEFITS / COSTS	.3799	.9339

This analysis discloses that the west side location for the new highway would provide the highest ratio of benefits to costs. Each $1.00 spent for construction and maintenance on this route would provide benefits equal to $0.93; each $1.00 of cost on the east side location would provide benefits equal to only $0.38.

The analysis to this point has been concerned only with the relationship of costs to benefits in connection with the construction of a new section of primary highway in this vicinity. Some consideration must also be granted to overall effect on all highway transportation in this general area.

If the main highway were to be relocated on the west side of the river, it would be necessary for the present highway on the east side of the river to be transferred to the secondary system so that the local residents would continue to be served by an adequate highway. It appears that this local service could adequately be provided for by designating as a secondary route the portion of the present highway from the Carter Bridge southward to a point at the junction with FAS Route 362. This section of highway together with FAS Route 362, would provide a continuous route between the Carter Bridge and a point on the west side highway near Emigrant. The length of the route would be approximately 21.9 miles.

This routing would comply with the standards for a secondary system highway, but it would undoubtedly be necessary to resurface the present highway at some future date. It would also be necessary to construct an oil mat on the present gravel surface of FAS Route 362. It is estimated that this work could be accomplished at a cost of $18,000 per mile for 21.9 miles, or a total cost of $394,200 for the entire route. Assuming that the reconstructed highway would continue to serve for 30 years, an annual cost of $13,140 would result. In addition, the county would be charged with the cost of maintaining this highway at an approximate figure of $400 per mile per year, or a total annual cost for the 21.9 miles of $8,760.

If the main highway were to be reconstructed on the east side of the river, it is essential that provision be made for the construction of a secondary system highway on the west side of the river. The amount of development and the traffic on the west side is sufficient to warrant the designation of an FAS Route to serve the residents in this vicinity. In order to provide the greatest benefit to the local residents, it would be necessary for this routing to follow quite closely the present county road so that direct service could be provided to the local dwellings. The traffic of interest would extend from the Carter Bridge to a road junction at Big Creek, a distance of about 26.5 miles. Traffic at the north end of this route, and in the vicinity of Emigrant, is already sufficiently high to justify construction of an oiled surface between these two points. The future traffic on the remainder of the route would undoubtedly increase to the point that would justify an oiled surface on the entire route.

It is estimated that the construction of this route to an oiled standard, and the resurfacing of the route at some future date, would cost about $38,000 per mile, or a total cost of $1,007,000 for the new highway. The assignment of a 30 year service life to this highway would result in an annual construction cost of $33,567. It is also estimated that the cost of maintaining this route would equal $400 per mile per year, or $10,600 per year for the 26.5 miles.

There would also be benefit to the local residents as the result of secondary highway construction on either side of the river. The reconstruction of the present highway on the east side of the river would provide only minor benefit, since it is presumed that the present alignment would be followed quite closely in order to serve as many residents as possible.

For this reason, no allowance is made for distance shortening. The resurfacing of the present roadway would undoubtedly improve the riding ability and would permit better safe speed. At the present time, FAS Route 362 from the main highway to Emigrant has a gravel surface. Construction of an oiled surface on this section of road would provide substantial benefits per mile of travel, but since this section is only two miles long, the overall benefit would not be great.

The construction of a new secondary highway on the west side of the river would provide a substantial benefit to the local residents in that vicinity. In meeting secondary requirements, it would be necessary to follow the present road quite closely in order to serve the greatest number of dwellings. For this reason, there would not be any appreciable shortening of travel distance over the present road. There would be significant benefits, however, in the change from the present low standard road to a modern oiled highway.

The computation of benefits for the secondary construction is shown in the following table:

COMPUTATION OF BENEFITS FROM SECONDARY SYSTEM CONSTRUCTION

	Average Daily Traffic	Annual Traffic (x 365)	Roadway Length	Annual Vehicle Miles	Savings Per VM	Total Savings
EAST SIDE SECONDARY						
Present highway	186	67,890	19.9	1,351,011	$.0048	$ 6,485
FAS 362	120	43,800	2.0	87,600	.0243	2,129
TOTAL ANNUAL SAVINGS						$ 8,614
WEST SIDE SECONDARY						
Entire route	100	36,500	26.5	967,250	$.0269	$26,019
TOTAL ANNUAL SAVINGS						$26,019

Upon multiplying these benefit figures by the estimated traffic increase of 25% over a 30 year period, the future annual benefits are increased to $10,767 and $32,524 respectively for the east side and the west side secondary routes.

In making a composite analysis for both the primary and secondary construction on both sides of the river, it is necessary to combine the costs and benefits as follows:

Primary system highway on the east side and a secondary system highway on the west side

Primary system highway on the west side and a secondary system highway on the east side

The costs and benefits are compared in the following:

ANNUAL VALUES	EAST SIDE PRIMARY AND WEST SIDE SECONDARY	WEST SIDE PRIMARY AND EAST SIDE SECONDARY
Primary construction	$ 87,356	$ 77,963
Secondary construction	33,567	13,140
Subtotal	120,923	91,103
Primary maintenance	24,000	22,875
Secondary maintenance	10,600	8,760
Subtotal	34,600	31,635
TOTAL COSTS	$ 155,523	$ 122,738
Primary benefits	$ 42,300	$ 94,176
Secondary benefits	32,524	10,767
TOTAL BENEFITS	$ 74,824	$ 104,943
BENEFITS / COSTS	.4811	.8550

The composite analysis shows that the combination of a west side primary and an east side secondary would provide the greatest benefit in relation to cost. Benefits on this combination would equal about $0.86 for each $1.00 of cost. The benefits on the combination of an east side primary and a west side secondary would equal about $0.48 for each $1.00 of cost.

SUMMARY

The results of this analysis show that the construction of a new primary highway on the west side of the river would provide the greatest benefit in relation to the costs involved. This location has the advantage of a lower construction cost, greater value of benefits to through traffic because of shorter travel distance, and greater benefits to local traffic because of the improvement of travel conditions from a low standard county road to a high standard paved highway.

Construction costs for a primary highway on the east side of the river are higher than those on the west side, and the benefits to through traffic are lower because of only a minor shortening in travel distance. Benefits to local traffic are also lower than those on the west side because of the fact that the local residents already are served by an oiled highway and the reconstruction of this highway to the same surface type would provide only minor benefits to this type of traffic.

Amortized construction costs and maintenance costs on the west side location would be about 10% lower than corresponding costs on the east side and the benefits on the west side would be about 120% higher than the benefits on the east side. In the relationship of benefits to costs, the west side location would have a rating more than twice as high as the east side routing.

When the situation is analyzed with respect to both primary and secondary highway development in this region, it is found that the amortized construction costs and the maintenance costs for a west side primary highway and an east side secondary highway are about 20% lower than the corresponding costs for an east side primary highway and a west side secondary highway. The benefits for the west side primary highway and the east side secondary highway are about 40% higher than the benefits for the combination of an east side primary highway and a west side secondary highway. In the relationship of benefits to costs, the combination of a west side primary highway and an east side secondary highway would have a rating almost twice as high as the combination of an east side primary highway and a west side secondary highway.

All conditions appear to favor the construction of the primary highway on the west side of the river and the transfer of the present east side primary highway to the secondary system. Such a secondary system highway should extend from the Carter Bridge Junction southward to a point at the junction with the Emigrant secondary highway. In combination with the Emigrant highway, a route would be provided which would connect at both ends with the west side primary highway.